<u>WHAT IS CLAIMED IS :</u>

1. A method of forming a patterned polymeric film, comprising the steps of:

providing a first electrode positioned in a first plane, and a second electrode positioned in a second plane different from the first plane,

providing a polymerization mixture comprising a monomer and an initiator in an electrolyte solution wherein said polymerization mixture is located between the first and the second electrode; and

generating an AC electric field at an interface between said second electrode and said electrolyte solution, the second electrode comprising either

(a) a light-sensitive electrode, wherein the method further comprising the step of illuminating said second electrode with a predetermined light pattern, such that the illumination in combination with the generating of the AC field at said interface results in formation of a patterned film in a designated area of the second electrode, said designated area being defined by the illumination pattern; or

(b) a electrode having a surface and an interior, the surface or interior having been modified to produce spatial modulations in properties of the second electrode, said properties affecting the local distribution of the electric field at the interface, such that the generation of the AC electric field results in formation of the patterned film in a designated area of the second electrode, said designated area being defined by the spatial modulations in the properties of the second electrode.

2. The method of claim 1, wherein the polymerization mixture comprises a monomer, a cross-linker and an initiator.

3. The method of claim 1, wherein the polymerization mixture comprises a hydrophillic

monomer, a crosslinker and an initiator dissolved in an electrolyte solution, the electrolyte solution comprising an aqueous solution and wherein the polymeric film comprises a hydrogel.

4. The method of claim 1, wherein the polymerization mixture has an ionic concentration of about 1 mM or less.

5. The method of claim 1, wherein the polymerization mixture is a viscosity of about 100 cp or less.

6. The method of claim 1, wherein the polymeric film comprises a cross-linked alkylacrylamide or hydroxyalkylmethacrylate hydrogel.

7. The method of claim 1, wherein the initiator is a heat-activated initiator, and the method further comprises the step of heating the mixture to initiate the polymerization.

8. The method of claim 1, wherein the patterned film comprises a biosensor, said method further comprising the step of functionalizing the polymeric film by covalently attaching to said film a compound selected from the group consisting of a biomolecule, a pH sensor, a temperature sensor, a light-sensor and an oxygen sensor.

9. The method of claim 1, wherein the second electrode comprises a Si/SiOx electrode.

10. The method of claim 1, wherein the polymeric film comprises a polyacrylamide gel and the polymerization mixture further comprises preformed polymers, such that when the polymerization of said mixture forms a porous polyacrylamide gel.

11. The method of claim 1, wherein the first and the second electrode each comprises a planar electrode, said electrodes being parallel to each other and separated by a gap, with the polymerization mixture located in said gap, and wherein the electric field is generated by applying an AC voltage between the electrodes.

12. The method of claim 1, wherein the second electrode comprises a planar electrode having a surface and an interior, the surface or interior having been modified to produce spatial modulations in properties of the second electrode, said properties affecting the local distribution of the electric field at the interface.

13. The method of claim 10, wherein the second electrode comprises a silicon electrode.

14. The method of claim 10, wherein the properties of the second electrode comprises interfacial impedance, one or more areas of the surface or the interior of the second electrode being modified to exhibit low impedance, and wherein the patterned film are formed in the areas of low impedance.

15. The method of claim 12, wherein the spatial modulation of the properties of the second electrode is carried out by modifying the surface or interior of the second electrode by spatially modulated oxide growth, surface charge patterning or surface profiling.

16. The method of claim 12, wherein the initiator is a heat-activated initiator, and the method further comprises the step of heating the mixture to initiate the polymerization, wherein the step of heating in combination with the AC electric field generation resulting in the formation of the patterned film.

17. The method of claim 1, wherein the second electrode comprises a light-sensitive

electrode, the method further comprising the step of illuminating said second electrode with a predetermined light pattern, such that the illumination in combination with the AC field generation resulting in formation of the patterned polymeric film.

18. The method of claim 17, wherein the initiator comprises a heat-activated initiator and the method further comprises hearing the polymerization mixture to initiate the polymerization, wherein the step of heating in combination with the illumination and the AC electric field generation results in the formation of the patterned film.

19. The method of claim 17, wherein the second electrode comprises a silicon electrode.

20. A method of forming an assembly of particles embedded in a polymeric film, comprising the steps of:

providing a first electrode positioned in a first plane, and a second electrode positioned in a second plane different from the first plane,

providing a polymerization mixture comprising a monomer and an initiator in an electrolyte solution wherein said polymerization mixture is located between the first and the second electrode;

providing a plurality of particles suspended in said solution;

generating an AC electric field at an interface between said second electrode and said electrolyte solution, the second electrode comprising either

(a) a light-sensitive electrode, the method further comprising the step of illuminating said second electrode with a predetermined light pattern, such that the illumination in combination with the generating of the AC field at said interface results in formation of an assembly of particles in a designated area of the second electrode, said designated area being defined by the illumination pattern; or

(b) a electrode having a surface and an interior, the surface or interior having been

modified to produce spatial modulations in properties of the second electrode, said properties affecting the local distribution of the electric field at the interface, such that the generation of the AC electric field results in formation of an assembly of particles in a designated area of the second electrode, said designated area being defined by the spatial modulations in the properties of the second electrode; and

polymerizing the polymerization mixture to form a polymeric film, wherein the polymerization step results in formation of a polymer-particle composite film, said composite film comprising the assembly of particles embedded in the polymeric film.

21. The method of claim 20, wherein the polymerization mixture comprises a monomer, a cross-linker and an initiator.

22. The method of claim 20, wherein the polymerization mixture comprises a hydrophillic monomer, a crosslinker and an initiator dissolved in an electrolyte solution, the electrolyte solution comprising an aqueous solution and wherein the polymeric film comprises a hydrogel.

23. The method of claim 20, wherein the polymerization mixture has an ionic concentration of about 1 mM or less.

24. The method of claim 20, wherein the polymerization mixture is a viscosity of about 100 cp or less.

25. The method of claim 20, wherein the polymeric film comprises a cross-linked alkylacrylamide or hydroxyalkylmethacrylate hydrogel.

26. The method of claim 20, wherein the initiator is a heat-activated initiator, and the

polymerization step comprises heating the mixture to initiate the polymerization while maintaining the interfacial electric field.

27. The method of claim 20, wherein the initiator is photoactivable initiator, and the polymerization step comprises irradiating the mixture to initiate the polymerization.

28. The method of claim 20, wherein the polymeric film comprises a polyacrylamide gel and the polymerization mixture further comprises preformed polymers, such that the polymerization of said mixture forms a porous polyacrylamide gel.

29. The method of claim 20, wherein the first and the second electrode each comprises a planar electrode, said electrodes being parallel to each other and separated by a gap, with the polymerization mixture and the particles located in said gap, and wherein the electric field is generated by applying an AC voltage between the electrodes.

30. The method of claim 20, wherein the second electrode comprises a planar electrode and the particles are assembled in a planar assembly.

31. The method of claim 30, wherein the particles are assembled in a planar array, said particles comprising beads having biomolecules attached to their surfaces.

32. The method of claim 31, wherein the beads comprise different bead types, said bead types being distinguishable by the biomolecules attached thereto, and wherein the beads of each type are further distinguishable by a unique chemical or physical characteristic that identifies said bead type.

33. The method of claim 32, wherein the beads are encoded with a chemical label, said

chemical label comprising fluorophore dyes.

34. The method of claim 31, wherein the array comprises subarrays that are spatially separated from each other, and the polymeric film comprises a patterned polymeric film.

35. The method of claim 30, wherein the particles comprise magnetic particles.

36. The method of claim 30, wherein the particles comprise eukaryotic or prokaryotic cells.

37. The method of claim 30, wherein the particles comprise liposomes.

38. The method of claim 20, wherein the particles comprise inorganic particles.

39. The method of claim 20, wherein the second electrode comprises a planar electrode having a surface and an interior, the surface or interior having been modified to produce spatial modulations in properties of the second electrode, said properties affecting the local distribution of the electric field at the interface.

40. The method of claim 39, wherein the second electrode comprises a silicon electrode.

41. The method of claim 39, wherein the properties of the second electrode comprises interfacial impedance, one or more areas of the surface or the interior of the second electrode being modified to exhibit low impedance, and wherein the particles are assembled in the areas of low impedance.

42. The method of claim 41, wherein the spatial modulation of the properties of the second electrode is carried out by modifying the surface or interior of the second electrode by

spatially modulated oxide growth, surface charge patterning or surface profiling.

43. The method of claim 39, wherein the initiator comprises a heat-activated initiator, and the polymerization step comprises heating the mixture to initiate the polymerization, wherein the step of heating in combination with the AC field results in formation of the polymer-particle composite film.

44. The method of claim 39, wherein the initiator comprises a photoactivated initiator, and the polymerization step comprises irradiating the mixture to initiate the polymerization, wherein the step of heating in combination with the AC field results in formation of the polymer-particle composite film.

45. The method of claim 20 , wherein the second electrode comprises a light-sensitive electrode, the method further comprising the step of illuminating said second electrode with a predetermined light pattern, such that the illumination in combination with the AC field generation resulting in assembly of the particles.

46. The method of claim 45, wherein the second electrode comprises a silicon electrode.

47. The method of claim 45, wherein the initiator comprises a heat-activated initiator, and the polymerization step comprises heating the mixture to initiate the polymerization, wherein the step of heating and illumination in combination with the AC field results in formation of the polymer-particle composite film.

48. The method of claim 45, wherein the initiator comprises a photoactivated initiator, and the polymerization step comprises irradiating the mixture to initiate the polymerization, wherein the step of hearing and illumination in combination with the AC field results in

formation of the polymer-particle composite film.

49. A polymer-bead composite film comprising:

a planar assembly of beads embedded in a hydrophillic polymeric matrix, wherein said beads have biomolecules attached to their surfaces, said beads comprising different types of beads distinguishable by the biomolecules attached thereto, and wherein the beads of each type are further distinguishable by a unique chemical or physical characteristics that identifies said bead type.

50. The polymer-bead composite film of claim 49, wherein the biomolecules comprise peptides or proteins.

51. The polymer-bead composite film of claim 49, wherein the biomolecules comprise oligonucleotides or nucleic acids.

52. The polymer-bead composite film of claim 49, wherein the biomolecules comprise ligands or receptors.

53. The polymer-particle composite film of claim 49, wherein the beads are arranged in a planar array on a substrate.

54. The polymer-bead composite film of claim 50, wherein the substrate comprises a silicon chip.

55. The polymer-bead composite film of claim 50, wherein said film is self-supporting.

56. The polymer-bead composite film of claim 50, wherein the beads have an average

diameter of 0.5 um to 100 um.

57. The polymer-bead composite film of claim 50, wherein the matrix comprises cross-linked alkylacrylamide or hydroxyalkylacrylate hydrogel.

58. The polymer-bead composite film of claim 50, wherein the beads comprise magnetic beads.

59. A polymer-bead composite film comprising:

a planar assembly of beads embedded in a hydrophillic polymeric matrix, said assembly being formed by the method of claim 20, wherein said beads have biomolecules attached to their surfaces, said beads comprising different types of beads being distinguishable by the biomolecules attached thereto, and wherein the beads of each type are further distinguishable by a unique chemical or physical characteristic that identifies said bead type.

60. A polymer-cell composite film comprising a planar assembly of eukaryotic or prokaryotic cells embedded in a hydrophillic polymeric matrix, said assembly being formed by the method of claim 20.

61. The polymer-cell composite film of claim 61, wherein the film is self-supporting.

62. The polymer-cell composite film of claim 61, wherein the film is on a silicon chip.

63. The polymer-cell composite film of claim 61, wherein the matrix comprises cross-linked alkylacrylamide or hydroxylalkymethacrylate hydrogel.

64. A method of detecting a binding interaction between a biomolecule and its target

compound comprising:

providing a planar assembly of beads embedded in a hydrophillic polymeric matrix, wherein said beads have biomolecules attached to their surfaces, said beads comprising different types of beads distinguishable by the biomolecules attached thereto, and wherein the beads of each type are further distinguishable by a unique chemical or physical characteristic that identifies said bead type;

contacting said beads with a target compound so as to allow the target compound to bind to the corresponding biomolecule to form a target-biomolecule complex;

detecting the formation of the target-biomolecule complex; and

identifying the biomolecule of the target-biomolecule complex by means of the unique chemical or physical characteristic of the beads associated with said complex.

65. A method of detecting a binding interaction between a binding interaction between a cell receptor and its target compound comprising:

providing a polymer-cell film composite comprising a planar assembly of eukaryotic or prokaryotic cells embedded in a hydrophillic matrix, wherein said composite is prepared by the method of claim 20;

contacting said cells with a target compound so as to allow the target compound to bind to a corresponding receptor on said cells;

detecting the binding.

65. A method of performing a functional cellular assay comprising:

providing a polymer-cell film composite comprising a planar assembly of cells embedded in a hydrophillic polymeric matrix, wherein said composite is prepared by the method of claim 20.

exposing said cells to a target compound;

detecting the response of said cell to said target compound.

66. A method of forming an assembly of particles embedded in a gel, comprising the steps of:

providing a first electrode positioned in a first plane, and a second electrode positioned in a second plane different from the first plane,

providing a gellable component in an electrolyte solution, wherein the formation of a gel by said gellable component is temperature dependent and wherein said component is located between the first and the second electrode;

providing a plurality of particles suspended in said solution;

generating an AC electric field at an interface between said second electrode and said electrolyte solution, the second electrode comprising either

(a) a light-sensitive electrode, the method further comprising the step of illuminating said second electrode with a predetermined light pattern, such that the illumination in combination with the generating of the AC field at said interface results in formation of an assembly of particles in a designated area of the second electrode, said designated area being defined by the illumination pattern; or

(b) a electrode having a surface and an interior, the surface or interior having been modified to produce spatial modulations in properties of the second electrode, said properties affecting the local distribution of the electric field at the interface, such that the generation of the AC electric field results in formation of an assembly of particles in a designated area of the second electrode, said designated area being defined by the spatial modulations in the properties of the second electrode; and

decreasing the temperature of said gellable component, while maintaining the AC field, to form a polymer-particle composite gel, said composite gel comprising the assembly of particles embedded in a gel.

67. The method of claim 66, wherein the gellable component comprises agarose.

68. A method of modifying a bounding surface of a chemical reactor in accordance with a pre-

conceived layout, comprising the steps of:

preparing a patterned film according to claim 1, wherein the second electrode comprises a bounding surface of a chemical reactor;

performing a first selective chemical modification, wherein the area of the second electrode that is covered with the film or the area of the second electrode that is not covered with the film is modified;

removing the film; and

performing a second selective chemical modification of the area of the second electrode, wherein the area newly exposed by the removal of the film is modified.

69. A method of modifying a bounding surface of a chemical reactor in accordance with a pre-conceived layout, comprising the steps of:

preparing a patterned polymer-microparticle film composite composed of one or more discrete planar array of particles, wherein said composite is prepared according to claim 20 and wherein said second electrode comprises a bounding surface of a chemical reactor;

performing a first selective chemical modification, wherein the area of the second electrode that is covered with the film or the area of the second electrode that is not covered with the film is modified;

removing the film;

removing the particle array by removal of the electric field; and

performing a second selective chemical modification of the area of the second electrode, wherein the area newly exposed by the removal of the film is modified.

70. A method of sorting one population of particles from another comprising the following steps:

providing a cell comprising a first electrode positioned in a first plane, and a second electrode positioned in a second plane different from the first plane,

providing a polymerization mixture comprising a monomer and an initiator in an electrolyte solution wherein said polymerization mixture is located between the first and the second electrode;

providing a plurality of particles suspended in said solution, said particles comprising a mixture of at least two populations of particles having different relaxation frequencies;

applying an AC electric field to an interface between said second electrode and said electrolyte solution, said AC field having a selected frequency to selectively assemble an array composed of particles having relaxation frequencies exceeding the frequency of the applied field, but not those particles having relaxation frequencies less than said applied frequency, wherein the second electrode comprises

(a) a light-sensitive electrode, the method further comprising the step of illuminating said second electrode with a predetermined light pattern, such that the illumination in combination with the generating of the AC field at said interface results in formation of the array in a designated area of the second electrode, said designated area being defined by the illumination pattern; or

(b) a electrode having a surface and an interior, the surface or interior having been modified to produce spatial modulations in properties of the second electrode, said properties affecting the local distribution of the electric field at the interface, such that the generation of the AC electric field results in formation of an array of particles in a designated area of the second electrode, said designated area being defined by the spatial modulations in the properties of the second electrode;

polymerizing the polymerization mixture to form a polymeric film, wherein the polymerization step results in formation of a polymer-particle composite film, said composite film comprising the array of particles embedded in the polymeric film; and

removing from the cell the particles from that are not assembled in the array, wherein the particles are removed either before or after the polymerization step.

71. A method of sorting one population of particles from another comprising the steps of:

providing a first electrode positioned in a first plane, and a second electrode positioned in a second plane different from the first plane,

providing a gellable component in an electrolyte solution, wherein the formation of a gel by said gellable component is temperature dependent and wherein said component is located between the first and the second electrode;

providing a plurality of particles suspended in said solution, said particles comprising a mixture of at least two populations of particles having different relaxation frequencies;

applying an AC electric field at an interface between said second electrode and said electrolyte solution, said AC field having a selected frequency to selectively assembly an array composed of particles having relaxation frequencies exceeding the frequency of the applied field, but not those particles having relaxation frequencies less than said applied frequency, wherein the second electrode comprises

(a) a light-sensitive electrode, the method further comprising the step of illuminating said second electrode with a predetermined light pattern, such that the illumination in combination with the generating of the AC field at said interface results in formation of an assembly of particles in a designated area of the second electrode, said designated area being defined by the illumination pattern; or

(b) a electrode having a surface and an interior, the surface or interior having been modified to produce spatial modulations in properties of the second electrode, said properties affecting the local distribution of the electric field at the interface, such that the generation of the AC electric field results in formation of an assembly of particles in a designated area of the second electrode, said designated area being defined by the spatial modulations in the properties of the second electrode;

removing from the cell the particles that are not assembled in the array; and

decreasing the temperature of said gellable component, while maintaining the AC field, to

form a polymer-particle composite gel, said composite gel comprising the assembly of particles embedded in gel.

72. The method of claim 72, further comprising the step of increasing the temperature of said gellable component to release the particles from the array.

73. A method of producing an organized, multiconstituent assembly by transforming a homogeneous fluid mixture or suspension of comprising a gellable component and a plurality of particles provided in a reactor, into one or more heterogeneous assemblies, said assemblies being composed and organized in accordance with a preconceived design, by performing a timed sequence of two or more unit transformations, the method comprising the steps of:

(a) actively forming a preconceived spatial arrangement of a plurality of particles in a designated regions of one or more bounding surfaces of a reactor, wherein the active formation is mediated by an external field and sustained in said arrangement after the formation by said field; and

(b) starting a formation of a gel, in the presence of the external field, to form a gel-microparticle composite.

74. A method of claim 73, further comprising the step of modifying said particles.

75. A method of claim 74, wherein the modification comprises attachment of biomolecules to said particle surfaces.

76. A method of claim 73, further comprising the step of modifying the gel.

77. A method of claim 76, wherein the modification of gel comprises functionalization of the

gel by covalent attachment of biomolecules.

78. A method of claim 73, wherein the particles or the embedding fluid are magnetically polarizable, and external field applied comprises a magnetic field, said field being in a direction substantially normal to one of the reactor bounding surfaces.

79. A method of claim 73, wherein the arrangement is composed of an arrangement of particles within a plane of the bounding surface or in liner strings oriented substantially normal to the bounding surface.

80. A method of producing an organized, multiconstituent assembly by transforming a homogeneous fluid mixture or suspension comprising a gellable component and a plurality of particles provided in a reactor, into one or more heterogeneous assemblies, said assemblies being composed and organized in accordance with a preconceived design, by performing a timed sequence of two or more triggered unit transformations, the method comprising the steps of:

(a) actively forming a preconceived spatial arrangement of a plurality of particles in a designated regions of one or more bounding surfaces of a reactor, wherein the active formation is mediated by an external field and sustained in said arrangement after the formation by said field, wherein the active formation step is carried out according to claim 20;

(b) starting a formation of a gel, in the presence of the external field, to form a gel-microparticle composite.

81. A method of producing an organized, multiconstituent assembly by transforming a homogeneous fluid mixture or suspension comprising a gellable component and a plurality of particles provided in a reactor, into one or more heterogeneous assemblies, said

assemblies being composed and organized in accordance with a preconceived design, by performing a timed sequence of two or more triggered unit transformations, the method comprising the steps of:

(a) actively forming a preconceived spatial arrangement of a plurality of particles in a designated regions of one or more bounding surfaces of a reactor, wherein the active formation is mediated by an external field and sustained in said arrangement after the formation by said field, wherein the active formation step is carried out according to claim 66; and

(b) starting a formation of a gel, in the presence of the external field, to form a gel-microparticle composite.